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ACIDIC PRECIPITATION IN ONTARIO STUDY

ANNUAL STATISTICS OF CONCENTRATION DAILY AMBIENT AIR MONITORING NETWORK, 1981

September 1983

ARB-114-83-ARSP

APIOS-009/83

Ontario Ministry of the Environment

The Honourable
Andrew S. Brandt
Minister

Gérard J. M. Raymond
Deputy Minister

PART I

INTRODUCTION

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September, 1983

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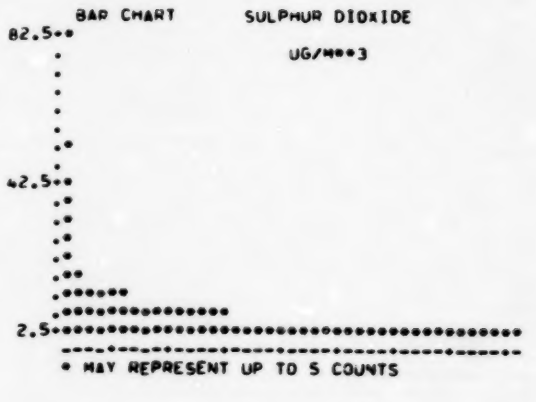
BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

CENTRAL REGION : DORSET



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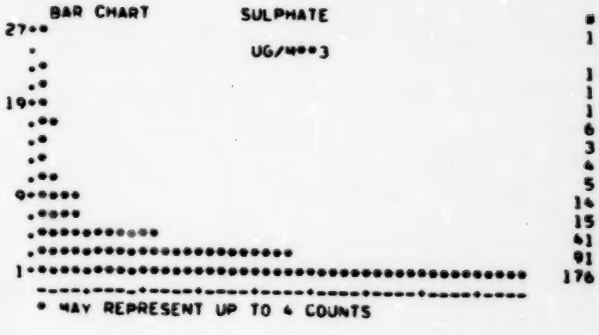

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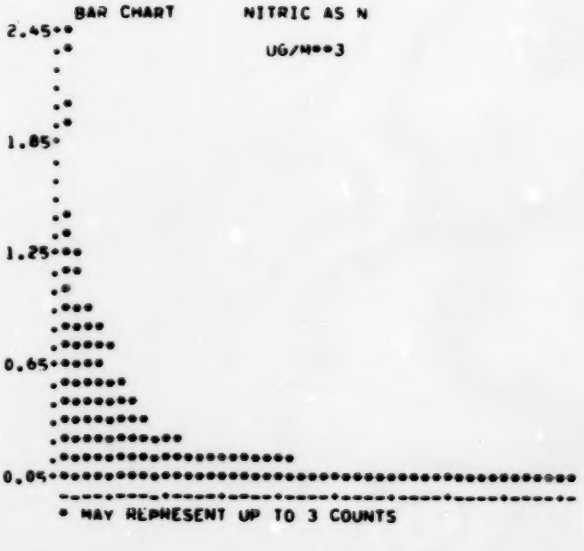

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	13
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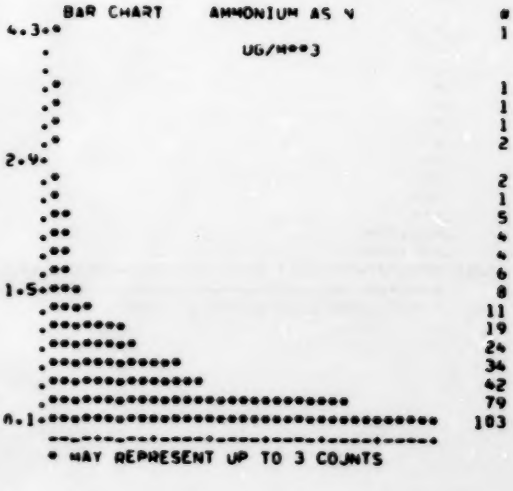
	22
	33
	63
	138



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	2
	1
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	4
	6
	8
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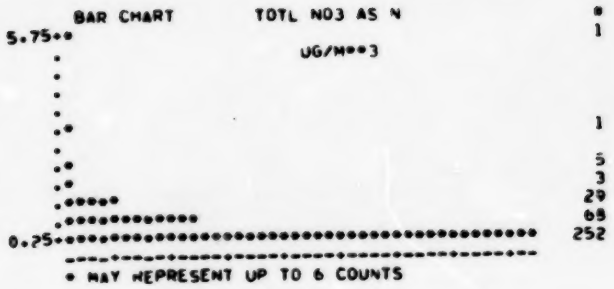
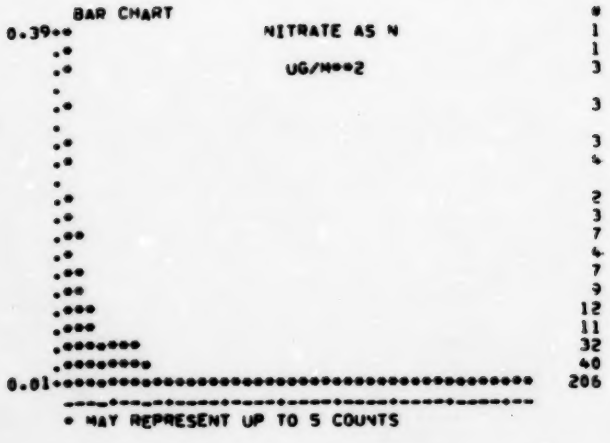
BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

CENTRAL REGION : DORSET





BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

NORTHWESTERN REGION : FERNBERG

```
STEM LEAF    SULPHUR DIOXIDE        #
   7 6                              1
   7              UG/M**3
   6
   6 3                              1
   5 8                              1
   5
   4 55                             2
   4
   3 55                             2
   3 1                              1
   2 57                             2
   2 12                             2
   1 556788999                      9
   1 00123444                       8
   0 66777778889999999             17
   0 00000000000111223344444       23
     ----+----+----+----+
```

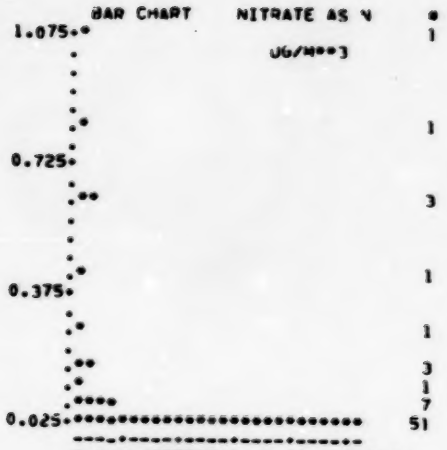
```
STEM LEAF       SULPHATE            #
  46 4                               1
  44              UG/M**3
  42
  40
  38 3                               1
  36
  34 36556                           5
  32 72                              2
  30 7                               1
  28 7                               1
  26
  24 2                               1
  22 6                               1
  20 25                              2
  18 2                               1
  16
  14 3695                            4
  12 02799                           5
  10 012399023334                   12
   8 1139148                         7
   6 2400123789                      9
   4 1478                            4
   2 379                             3
   0 000J4158                        8
     ----+----+----+----+
     MULTIPLY STEM.LEAF BY 10**-01
```

```
STEM LEAF        NITRIC AS N        #
  26 6                               1
  25              UG/M**3
  24
  23
  22
  21
  20
  19
  18
  17
  16
  15
  14
  13
  12
  11
  10 3                               1
   9
   8
   7
   6 1235                            4
   5 24                              2
   4 23478                           5
   3 1134                            4
   2 135689                          6
   1 00012234446668899              16
   0 000011112233444444556677778899 30
     ----+----+----+----+----+
     MULTIPLY STEM.LEAF BY 10**-01
```

```
STEM LEAF    AMMONIUM AS N          #
  19 4                               1
  18 9           UG/M**3             1
  17
  16
  15
  14 38                              2
  13
  12
  11 6                               1
  10 7                               1
   9 2                               1
   8 9                               1
   7 1356                            4
   6 03                              2
   5 8                               1
   4 368                             3
   3 01688                           5
   2 088024788                       9
   1 0012234556666788999            20
   0 0233445589                     10
     ----+----+----+----+
     MULTIPLY STEM.LEAF BY 10**-01
```

BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

NORTHWESTERN REGION : FERNBERG

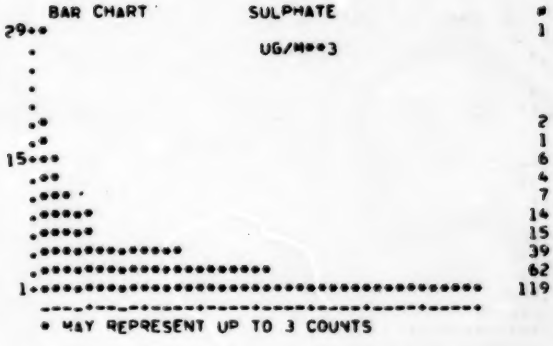


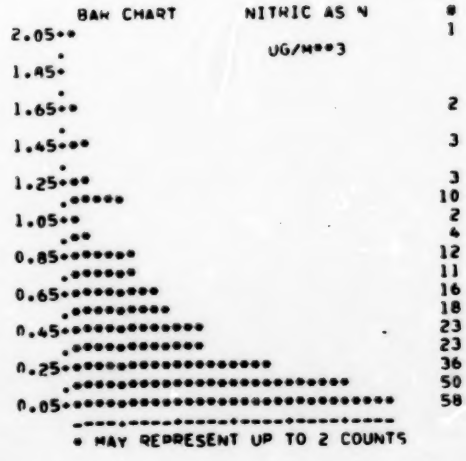
STEM	LEAF	TOTL NO3 AS N	#
32	0		1
30		UG/M**3	
28			
26			
24			
22			
20			
18	5		1
16	7		1
14			
12			
10	8		1
8	93		2
6	1469		4
4	3746		4
2	00222238892256		14
0	1111122222445555566678889000123344667 79		39

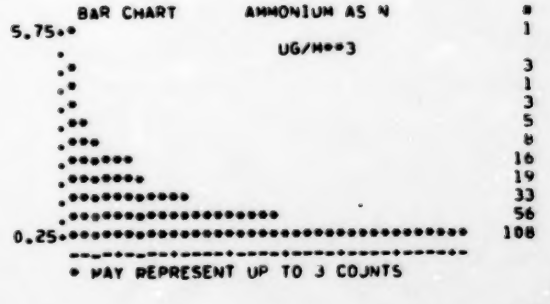
MULTIPLY STEM.LEAF BY 10**-01

BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

SOUTHEASTERN REGION : CHARLESTON LAKE







BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

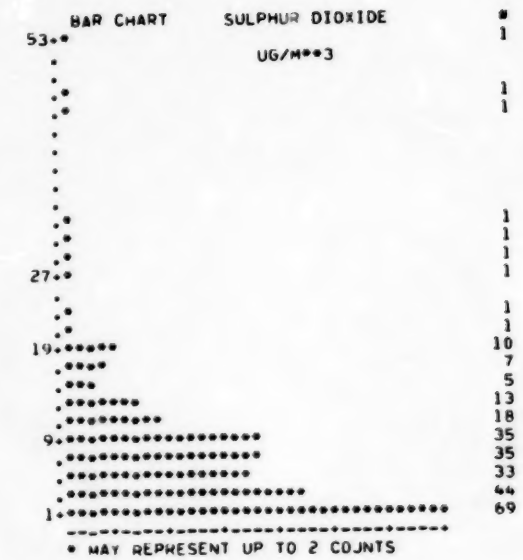
SOUTHEASTERN REGION : CHARLESTON LAKE

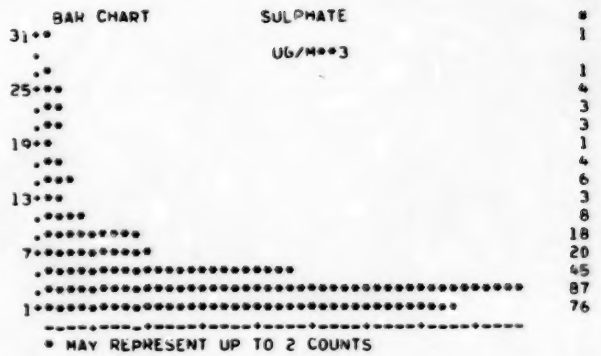
```
      BAR CHART     NITRATE AS N                    #
0.925+*                                             1
     .*                 UG/M**3                     2
     .*                                             1
     .*                                             2
0.725+**                                            4
     .
     .
     .**                                            4
     .**                                            4
0.475+*                                             1
     .*                                             2
     .*                                             3
     .***                                           7
0.275+***                                           9
     .****                                         12
     .******                                       18
     .************                                 35
     .**********************                       58
0.025+**********************************************108
     ---+-------+-------+-------+-------+-------+--
     * MAY REPRESENT UP TO 3 COUNTS
```

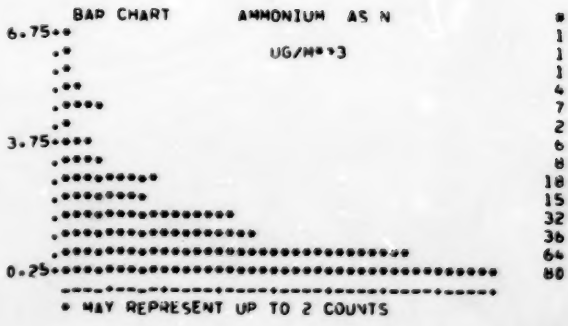
```
STEM LEAF          TOTL NO3 AS N                    #
  23 0                                              1
  22                   UG/M**3
  21
  20 4                                              1
  19
  18
  17 0167                                           4
  16 3478                                           4
  15 113899                                         6
  14 4                                              1
  13 5558                                           4
  12 45779                                          5
  11 4448                                           4
  10 02778                                          5
   9 11256777899                                   11
   8 001234455666777889                            18
   7 023344667899                                  12
   6 000001133334478889                            19
   5 000000112234558889                            19
   4 001122222344556777                            18
   3 000111233444455556666777888                   26
   2 000001122222223334555677777777899             33
   1 000111112234444444555666788888899999          37
   0 023333344444555556666666677778889999999999999 43
     ---+-------+-------+-------+-------+-------+--
     MULTIPLY STEM.LEAF BY 10**-01
```

BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

SOUTHWESTERN REGION : LONGWOODS







BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

SOUTHWESTERN REGION : LONGWOODS

```
     BAR CHART     NITRATE AS N          *
2.55+*                                   1
                     UG/M**3
    .*                                   1
    .
    .*                                   1
2.05+
    .*                                   1
    .*                                   1
    .**                                  3
    .*                                   2
1.55+**                                  3
    .*                                   1
    .***                                 5
    .*                                   1
    .**                                  4
1.05+*****                               8
    .******                              9
    .*****                               9
    .*****                              10
    .********                           16
0.55+************                       24
    .************                       23
    .***************                    30
    .**************                     28
    .********************               37
0.05+**********************************  64
    ----+----------+----------+----------
     * MAY REPRESENT UP TO 2 COUNTS
```

TEM	LEAF	TOTL NO3 AS N	#
32	0		1
30	2	UG/M**3	1
28	04		2
26	058		3
24	2		1
22	56		2
20	0116700789		10
18	0133578890458		13
16	02333560133446		14
14	2235556799990003359		19
12	2488002235679		13
10	00112334555666679999122344557 99		31
8	06701223336677778899		20
6	22234444555677888990001233445566788889		38
4	01223445566777888990011223355578999		34
2	01112334466088890011123444666 78999		35
0	01234556788888000001222333344445556666788999		45

MULTIPLY STEM.LEAF BY 10**-01

PART II

STATION DESCRIPTION AND LOCATION MAP

INTRODUCTION

The graphical and statistical summaries presented in this report pertain to the 1981 analytical results obtained from the Acidic Precipitation in Ontario Study (APIOS) daily ambient air monitoring network (see network overview report, #ARB-02-82-ARSP). The relevant data are listed in a previous report, #ARB-71-83-ARSP. All available data are utilized with the following modifications. Results reported as being unreliable or approximate are not included in the calculations. If it is noted that the actual result is greater than the reported value, the reported value is also excluded. If a detection limit is reported, a value corresponding to one half the detection limit is utilized for statistical calculations as reported in the statistical summaries. In the presented statistical summaries, "Nitric" represents "Nitric Acid" and "Totl NO_3" represents total nitrates calculated by the summation of particulate "Nitrate" and "Nitric Acid".

The Bar/Stem.Leaf charts presented in Part III are obtained from the SAS (Statistical Analysis System) Univariate procedure, SAS User's Guide 1979 Edition. The charting procedure optimizes as to what chart type to produce. The Bar charts are self explanatory. The Stem.Leaf charts may best be explained by an elementary example.

Example of Stem.Leaf Chart: Sulphur Dioxide ug/m**3

Stem	Leaf	#
2	555556666778999	15
	multiply stem.leaf by 10***01	

This chart would be interpreted as follows: of the 15 reported values, 5 results are equal to 2.5 x 10 ug/m**3, 4 results are equal to 2.6 x 10 ug/m**3, 2 results are equal to 2.7 x 10 ug/m**3, 1 result equals 2.8 x 10 ug/m**3, and 3 results are equal to 2.9 x 10 ug/m**3. It should be noted however, that all the original significant figures may not be represented.

The statistical summaries presented in Part IV include mean (arithmetic/geometric), standard deviation (arithmetic/geometric), sample size, maximum, minimum and quartiles. Users may assess the meaning of the statistical summaries in light of the sample distributions given in Part V.

The distribution of the observed concentration is examined by calculating the skewness, kurtosis and D-statistic of the observed results and log-transformed observed results. Ideal skewness and kurtosis for a normal distribution are 0 and 3 respectively. Skewness is considered to be significant if calculated to be less than -1 or greater than +1. The Kolomogorov-Smirnov D-statistic is calculated and compared to a critical value. If the D-statistic exceeds the critical value, then the null hypothesis of normality is rejected. In this report, the 95% confidence level is used. It is apparent from this analysis that the data more closely represent a Log-normal distribution. This is indicated by a reduction in the calculated D-statistic when a log-transformation is introduced. In many instances however, the calculated D-statistic is not sufficiently lowered so as to pass the normality criterion. This may well be attributed to abnormalities at the ends of the distribution such as having a few extreme outliers or excessive values at the detection Limit. In such instances it may be appropriate to use alternative methods for estimation of the sample mean and standard deviation which are insensitive to abnormalities in the extreme ends of the distribution. The median (m) and scale (s) of the distribution of log-transformed data may be used to estimate the sample mean (u) and sample standard deviation (σ) respectively. These alternative estimators would be calculated as follows: m = second quartile and s = 0.740 (third quartile - second quartile).

PART III

BAR/STEM.LEAF CHARTS OF OBSERVED CONCENTRATION

STATION LOCATION MAP

DAILY AMBIENT AIR MONITORING NETWORK

MAP REF NUMBER	STATION NAME	MOE REGION	ELEVATION (m)	LATITUDE NORTH	LONGITUDE WEST	UTM COORDINATES NORTHING	UTM COORDINATES EASTING
01	Longwoods	Southwestern	239	42°53'	81°29'	4747850	460700
02	Dorset	Central	320	45°13'	78°56'	5009600	662450
03	Charleston Lake	Southeastern	92	44°30'	76°03'	4927500	417150
04	Fernberg	Northwestern	506	47°50'	91°52'	5316000	585000

PART IV

SUMMARY STATISTICS OF OBSERVED CONCENTRATION

ONTARIO MINISTRY OF THE ENVIRONMENT
SUMMARY STATISTICS OF OBSERVED CONCENTRATIONS
APIOS - ACID PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/DAILY/SEQUENTIAL #02

PERIOD OF REPORT : DEC 31.80 TO JAN 1.82 PAGE : 1

	SULPHUR DIOXIDE UG/M**3	SULPHATE UG/M**3	NITRIC AS N UG/M**3	AMMONIUM AS N UG/M**3	NITRATE AS N UG/M**3	TOTL NO3 AS N UG/M**3
# OF SAMPLES	320.0	360.00	360.00	349.000	359.00	359.00
MAXIMUM	84.2	27.73	2.47	4.220	0.73	3.05
MINIMUM	0.0	0.00	0.00	0.000	0.00	0.00
RANGE	84.2	27.73	2.47	4.220	0.73	3.05
ARITH. MEAN	5.0	3.39	0.31	0.604	0.06	0.37
ARITH. STD. DEV	7.5	3.96	0.38	0.667	0.11	0.44
GEOM. MEAN	2.2	1.98	0.17	0.350	0.02	0.18
GEOM. STD. DEV.	1.5	1.12	1.31	1.284	1.55	1.37
1ST QUARTILE	0.8	1.11	0.05	0.161	0.00	0.07
2ND QUARTILE	2.8	2.06	0.15	0.356	0.01	0.17
3RD QUARTILE	7.0	3.99	0.46	0.806	0.05	0.55

***** : INSUFFICIENT DATA

ONTARIO MINISTRY OF THE ENVIRONMENT
SUMMARY STATISTICS OF OBSERVED CONCENTRATIONS
APIOS - ACID PRECIPITATION IN ONTARIO STUDY

STATION NAME : FERNBERG/DAILY/SEQUENTIAL #04

PERIOD OF REPORT : OCT 2,81 TO JAN 1,82

	SULPHUR DIOXIDE UG/M**3	SULPHATE UG/M**3	NITRIC AS N UG/M**3	AMMONIUM AS N UG/M**3	NITRATE AS N UG/M**3	TOTL NO3 AS N UG/M**3
# OF SAMPLES	69.0	68.00	69.00	62.000	69.00	67.00
MAXIMUM	7.6	4.74	2.66	1.939	1.05	3.30
MINIMUM	0.0	0.00	0.00	0.002	0.00	0.00
RANGE	7.6	4.74	2.66	1.937	1.05	3.30
ARITH. MEAN	1.3	1.33	0.23	0.390	0.09	0.31
ARITH. STD. DEV	1.5	1.12	0.36	0.439	0.20	0.52
GEOM. MEAN	1.0	0.92	0.14	0.220	0.06	0.14
GEOM. STD. DEV.	0.9	1.20	1.24	1.195	1.81	1.47
1ST QUARTILE	0.3	0.67	0.04	0.126	0.00	0.05
2ND QUARTILE	0.9	1.03	0.12	0.198	0.01	0.14
3RD QUARTILE	1.6	1.52	0.28	0.470	0.05	0.32

***** : INSUFFICIENT DATA

ONTARIO MINISTRY OF THE ENVIRONMENT
SUMMARY STATISTICS OF OBSERVED CONCENTRATIONS
APIOS - ACID PRECIPITATION IN ONTARIO STUDY

STATION NAME : CHARLESTON LAKE/DAILY/SEQUENTIAL #03

PERIOD OF REPORT : MAR 23,81 TO JAN 1,82

	SULPHUR DIOXIDE UG/M**3	SULPHATE UG/M**3	NITRIC AS N UG/M**3	AMMONIUM AS N UG/M**3	NITRATE AS N UG/M**3	TOTL NO3 AS N UG/M**3
# OF SAMPLES	265.0	270.00	272.00	253.000	271.00	271.00
MAXIMUM	39.0	29.14	2.09	5.505	0.93	2.30
MINIMUM	0.0	0.01	0.00	0.000	0.00	0.00
RANGE	39.0	29.13	2.09	5.505	0.93	2.30
ARITH. MEAN	4.0	3.71	0.39	0.941	0.13	0.52
ARITH. STD. DEV	5.0	3.99	0.36	0.986	0.18	0.45
GEOM. MEAN	2.0	2.10	0.24	0.517	0.07	0.33
GEOM. STD. DEV.	1.3	1.21	1.11	1.273	1.33	1.04
1ST QUARTILE	1.0	0.98	0.11	0.243	0.03	0.17
2ND QUARTILE	2.2	2.51	0.28	0.553	0.07	0.37
3RD QUARTILE	5.2	4.91	0.56	1.267	0.15	0.77

***** : INSUFFICIENT DATA

ONTARIO MINISTRY OF THE ENVIRONMENT
SUMMARY STATISTICS OF OBSERVED CONCENTRATIONS
APIOS - ACID PRECIPITATION IN ONTARIO STUDY

STATION NAME : LONGWOODS/DAILY/SEQUENTIAL #01

PERIOD OF REPORT : MAR 3,81 TO DEC 31,81 PAGE : 1

	SULPHUR DIOXIDE UG/M**3	SULPHATE UG/M**3	NITRIC AS N UG/M**3	AMMONIUM AS N UG/M**3	NITRATE AS N UG/M**3	TOTL NO3 AS N UG/M**3
# OF SAMPLES	278.0	280.00	287.00	275.000	282.00	282.00
MAXIMUM	52.6	31.32	1.79	6.926	2.51	3.30
MINIMUM	0.0	0.01	0.00	0.000	0.00	0.00
RANGE	52.6	31.31	1.79	6.926	2.51	3.30
ARITH. MEAN	7.1	5.16	0.44	1.341	0.45	0.90
ARITH. STD. DEV	7.2	5.46	0.43	1.301	0.45	0.68
GEOM. MEAN	4.0	3.23	0.28	0.830	0.26	0.62
GEOM. STD. DEV.	1.3	1.06	1.10	1.102	1.28	1.00
1ST QUARTILE	1.9	1.87	0.11	0.406	0.12	0.34
2ND QUARTILE	5.5	3.28	0.29	0.857	0.32	0.74
3RD QUARTILE	9.5	6.24	0.65	1.835	0.62	1.33

***** : INSUFFICIENT DATA

PART V

STATISTICAL DISTRIBUTION COMPARISON OF OBSERVED CONCENTRATION

STATISTICAL DISTRIBUTION COMPARISON OF OBSERVED CONCENTRATION NORMALITY VS. LOG-NORMALITY

CENTRAL REGION : DORSET

Variable	Units	Sample Size	Critical D $\alpha = 0.05$	Observed Results			$\log_e$ (Observed Results)		
				Skewness	Kurtosis	D Statistic	Skewness	Kurtosis	D Statistic
Sulphur Dioxide	ug/m**3	316	0.050	5.35	44.09	0.254	-0.48	-0.23	0.085
Sulphate	ug/m**3	358	0.047	2.72	8.99	0.200	-0.52	0.83	0.064
Nitric as N	ug/m**3	347	0.048	2.20	6.57	0.201	-0.32	-0.30	0.058
Ammonium as N	ug/m**3	339	0.049	2.18	5.87	0.177	-1.08	2.41	0.080
Nitrate as N	ug/m**3	328	0.049	2.63	7.12	0.264	0.24	-0.55	0.083
Total Nitrate as N	ug/m**3	318	0.050	1.99	5.13	0.187	-0.11	-0.78	0.062

* D-statistic passes normality criterion.

STATISTICAL DISTRIBUTION COMPARISON OF OBSERVED CONCENTRATION NORMALITY VS. LOG-NORMALITY

NORTHWESTERN REGION : FERNBERG

Variable	Units	Sample Size	Critical D $\alpha = 0.05$	Observed Results			$\log_e$ (Observed Results)		
				Skewness	Kurtosis	D Statistic	Skewness	Kurtosis	D Statistic
Sulphur Dioxide	ug/m**3	58	0.116	2.10	4.69	0.195	-0.40	0.24	0.095*
Sulphate	ug/m**3	65	0.110	1.22	0.64	0.228	-2.23	8.81	0.185
Nitric as N	ug/m**3	65	0.110	4.78	29.54	0.260	-0.33	0.25	0.059*
Ammonium as N	ug/m**3	62	0.112	2.00	3.84	0.231	-0.52	0.99	0.088*
Nitrate as N	ug/m**3	51	0.123	2.66	6.65	0.331	0.51	-0.50	0.152
Total Nitrate as N	ug/m**3	47	-	3.33	13.24	-	-0.04	0.26	-

* D-statistic passes normality criterion.

STATISTICAL DISTRIBUTION COMPARISON OF OBSERVED CONCENTRATION NORMALITY VS. LOG-NORMALITY

SOUTHEASTERN REGION : CHARLESTON LAKE

Variable	Units	Sample Size	Critical D $\alpha = 0.05$	Observed Results			$\log_e$ (Observed Results)		
				Skewness	Kurtosis	D Statistic	Skewness	Kurtosis	D Statistic
Sulphur Dioxide	ug/m**3	260	0.056	2.69	10.60	0.210	-0.53	0.37	0.060
Sulphate	ug/m**3	270	0.054	2.33	7.79	0.178	-0.68	0.65	0.062
Nitric as N	ug/m**3	271	0.054	1.46	2.37	0.146	-0.50	-0.39	0.077
Ammonium as N	ug/m**3	252	0.056	1.80	3.68	0.170	-0.82	0.94	0.055*
Nitrate as N	ug/m**3	267	0.055	2.45	6.17	0.227	-0.25	-0.03	0.036*
Total Nitrate as N	ug/m**3	267	0.055	1.26	1.22	0.136	-0.45	-0.56	0.072

* D-statistic passes normality criterion.

STATISTICAL DISTRIBUTION COMPARISON OF OBSERVED CONCENTRATION NORMALITY VS. LOG-NORMALITY

SOUTHWESTERN REGION : LONGWOODS

Variable	Units	Sample Size	Critical D $\alpha = 0.05$	Observed Results			$\log_e$ (Observed Results)		
				Skewness	Kurtosis	D Statistic	Skewness	Kurtosis	D Statistic
Sulphur Dioxide	ug/m**3	274	0.054	2.66	11.08	0.161	-1.32	2.84	0.104
Sulphate	ug/m**3	280	0.053	2.26	5.46	0.197	-0.93	4.18	0.059
Nitric as N	ug/m**3	277	0.054	1.21	0.76	0.152	-0.31	-0.82	0.070
Ammonium as N	ug/m**3	273	0.054	1.62	2.58	0.172	-0.78	1.53	0.047*
Nitrate as N	ug/m**3	279	0.053	1.69	3.27	0.156	-0.84	0.72	0.098
Total Nitrate as N	ug/m**3	274	0.054	0.91	0.49	0.106	-0.67	-0.26	0.099

* D-statistic passes normality criterion.